


## Slide 1 PPE



### Personal Protective Equipment

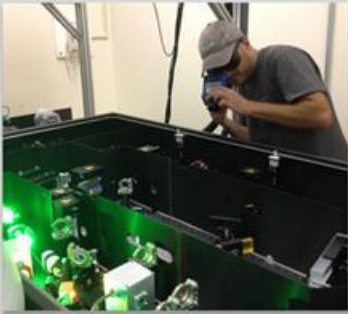

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### PPE


**After completing this module, you will be able to:**

- Recognize when laser eyewear or skin PPE is required
- Understand how laser eyewear works
- Recognize vital elements in selecting laser eyewear
- Identify common problems associated with laser eyewear
- Know proper storage for laser eyewear
- Check eyewear label information



PPE is the third level of control against laser hazards. You are the limiting factor with PPE. If you choose not to wear the appropriate laser protection you will not be protected. After completing this module, you will be able to: Recognize when laser eyewear or skin PPE is required, understand how laser eyewear works, recognize the vital elements in selecting laser eyewear, identify common problems associated with laser eyewear, know how to store your laser eyewear properly, and match eyewear labels to warning sign information.

## Slide 2 PPE



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#### Protective Clothing

- Worn for UV exposure hazards
- Wear when required by the safety documentation or your supervisor

#### UV Laser Operation


- Laser eyewear and skin protection are last line of defense!
- Increased emphasis on barriers and enclosures
- Reduce intensity



Laser eyewear is not the only type of laser PPE. When clothing is worn as PPE, it usually means there are UV exposure hazards. Such exposures can lead to both acute and chronic health effects such as skin burns or skin cancer. Wear protective clothing when required by the safety documentation or your supervisor. Working with ultraviolet wavelengths may require gloves, a long sleeve shirt or a face shield. For example: as little as 10 milliWatts laser power at UV wavelengths shorter than 300 nanometers may warrant needing gloves to protect against long exposures to diffuse reflections.

But remember - laser eyewear and skin PPE are the last line of defense! UV laser operation requires increased emphasis on employing barriers and enclosures, and on reducing intensity when there are open beams.

## Slide 3 PPE



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### Laser Eyewear

Required for all Class 3B or Class 4 beams!


**Full protection eyewear:**

- Reduces exposure to a safe level below the Maximum Permissible Exposure (MPE)
- **Required** for all routine laser operations **and** for most alignment procedures

**Alignment eyewear:**

- Has reduced Optical Density (OD) from full protection eyewear
- Is only for specific visible wavelength procedures
- **Requires** review and approval by the LSO
- Will **NOT** stop a full-power direct beam
- Should be stored in separate location from full protection eyewear


Consider using cameras and other diagnostics with full protection eyewear prior to using alignment eyewear!



Laser eyewear protection is required whenever there are accessible Class 3B or Class 4 laser beams. Full-protection eyewear is designed to reduce exposure to a level safely below the Maximum Permissible Exposure. It is required for all routine laser operations and for almost all alignment procedures. Alignment eyewear has a reduced optical density from full protection. It is only used for specific visible wavelength procedures that are reviewed and approved by the LSO. This type of eyewear will let you see an attenuated visible beam. Alignment eyewear will **NOT** stop a full-power direct beam. Store alignment eyewear in a different location from full protection eyewear. Before using alignment eyewear consider how to use cameras and other diagnostics!

## Slide 4 PPE

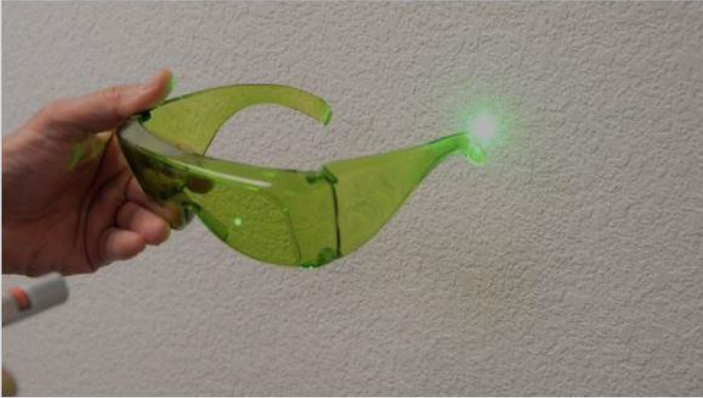
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### How Laser Eyewear Works

- Filter lowers beam intensity to Maximum Permissible Exposure (MPE)
- Below MPE = SAFE
- Above MPE = NOT SAFE



Here is a pair of tinted safety glasses. As you can see, the beam passes directly through the lens. Here is a pair of laser protective eyewear. The beam does not penetrate the lens and thus protects your eyes. And here is another pair of laser eyewear. But it has the wrong filter for the laser's green wavelength, and the laser beam passes through it with little attenuation. Correct laser eyewear has a filter designed to lower the intensity of the incident laser beam, either by reflection or absorption, to a safe level no higher than the Maximum Permissible Exposure, or MPE. Exposure below the MPE will not cause an eye injury.

## Slide 5 PPE




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#### Vital Elements in Eyewear Selection

- Optical Density (OD)
- Visible Light Transmission (VLT)
- Fit and comfort
- Prescription eyewear
- Viewing monitor displays and diagnostics
- Field of vision and side shield protection



To be effective, laser eyewear must be chosen for the specific work environment involved. The key factors to consider in selecting laser eyewear are: Optical Density, or OD, at each accessible wavelength; Visible Light Transmission, or VLT; fit and comfort; compatibility with prescription eyewear; ability to view monitors and diagnostics thru laser eyewear, and field of vision and side shield protection.

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**Optical Density (OD)**

Optical Density	% Radiation Transmission
1	10%
2	1%
3	0.1%
4	0.01%
5	0.001%
6	0.0001%
7	0.00001%

OD is calculated in base 10. That is, as OD increases, the protection against laser radiation increases by a factor of ten. OD 1 filters allow 10% transmission of the laser radiation. OD 2 allows 1%, OD 3 allows 0.1%, and so on.

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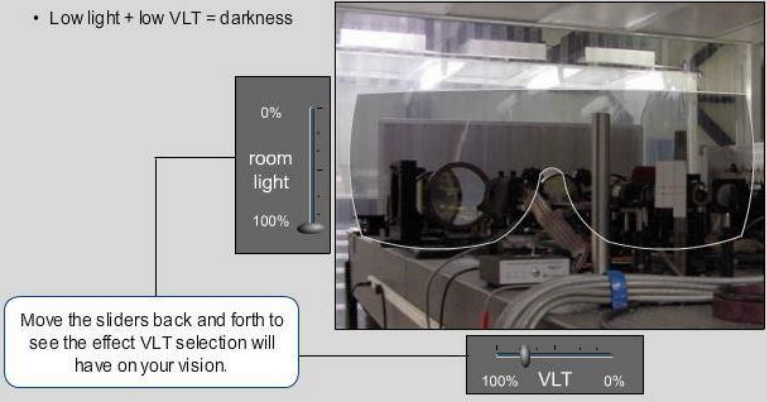
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### Visible Light Transmission (VLT)

- The higher the VLT, the easier it is to see
- Below 20% = very dark
- Low light + low VLT = darkness



0%  
room light  
100%

Move the sliders back and forth to see the effect VLT selection will have on your vision.

100% VLT 0%

Visible Light Transmission, or VLT, is another important selection factor with laser eyewear. The higher the VLT, the easier it is to see through the eyewear. VLTs below 20 percent are very dark, as seen here. Working in a low-light environment with low-VLT eyewear is like working in the dark - which can present its own unique safety hazards, such as tripping. Move the 2 sliders back and forth to see the effect of different room lighting levels and eyewear VLTs.

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#### Fit

**Comfort and proper coverage issues:**

- Clumsy or uncomfortable
- Weight
  - Multi-wavelength
  - Prescription

Improper fit



Large gap


Proper fit



Eyewear does not have to be light-tight but it must fit snugly. Beware of gaps that are too large. If needed, use head bands or tightening straps on frames to ensure a good fit. Both comfort and proper coverage must be considered. If your laser eyewear is clumsy, heavy, or just plain uncomfortable, you probably won't want to wear it. Don't find reasons not to wear eye protection. Your eyesight is too valuable! Weight is a particular concern when multi-wavelength or prescription eyewear is needed. Many frame style options are available and often lightweight polycarbonate filters can be used. Contact your laser safety officer to help you find the right PPE for the job.



## Slide 9 PPE

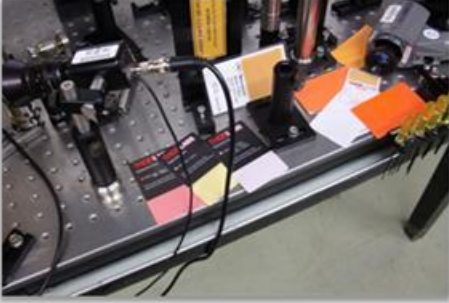


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#### Laser Beam Diagnostic Use



**CAUTION - Beware of hazardous reflections from coated sensor cards**

- Eyewear must allow you to see diagnostic signals, such as the fluorescence or glow from sensor cards
- Use cameras and viewers in addition to sensor cards

**And *always* use laser eyewear with Class 3B and Class 4 beams!**

Sensor cards are commonly used to locate laser beams. The beams strike the card and produce visible fluorescence that you can view through protective eyewear. Use caution with coated sensor cards – they can produce hazardous reflections. Cameras and viewers are other common beam diagnostics that are used. Good beam diagnostics will make it easier to do your work while wearing protective eyewear.

### ***Slide 10 PPE***



Another important consideration when choosing laser safety eyewear is your field of vision. Being able to see in a safe manner is of obvious importance. Look for eyewear that provides good peripheral vision. Pictured here is a pair of orange eyewear with protective side shields which provides good peripheral vision. These green goggles limit peripheral vision.

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**Common Problems with Laser Protective Eyewear**


- Not using it or using wrong filter eyewear
- Improper fit
- Multi-wavelength needs
- Limited visible light transmission
- Eyewear degradation
- Ultra-fast pulses



OD may significantly decrease

The primary problem with laser eyewear is when people don't use it or use the wrong filter eyewear. Remember: laser eyewear **MUST** be used when there are accessible Class 3B or Class 4 laser beams! Other problems include, improper fit, finding eyewear that meets multi-wavelength needs, limited Visible Light Transmission. Eyewear degradation (that is, aging or bleaching) may occur after prolonged exposure to ultraviolet wavelengths. The absorptive material is depleted to the point where the eyewear gets darker or the optical density is affected. Also, studies have shown that saturable absorption effects may cause the optical density of some filters to decrease significantly for short pulses at high irradiance levels. Never think your eyewear is a magic force-field. Eyewear has limitations.

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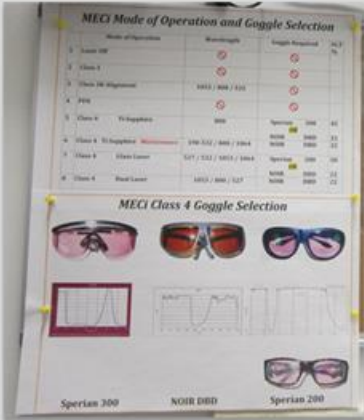

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### Eyewear Storage

**Good storage organization will:**

- Reduce scratches and extend the life
- Keep eyewear from getting misplaced or lost
- Help indicate eyewear type required



Store your eyewear in a clean, dry place. Good storage organization will: Reduce scratches and extend the life, keep eyewear from getting misplaced or lost, and help indicate the eyewear filter required for the wavelengths in use.

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### Eyewear Labeling

- Wavelength range
- OD at those wavelengths



OD7+ at 190-534 nm  
OD5+ at 850-925 nm  
OD7+ at 960-1064 nm



**WARNING**  
**Class 4 Laser Controlled Area**  
Avoid eye or skin exposure to direct or scattered radiation.

Wavelengths	Eyewear OD Required
532 nm	OD>6
1064 nm	OD>6

Laser Safety Officer: \_\_\_\_\_ Ext. \_\_\_\_\_

OD6+ required at 532 and 1064 nm

All laser safety eyewear must meet the ANSI Z-136.1 standard. Thus, at a minimum, all eyewear will be marked with the wavelength range and optical density for those wavelengths. Observe eyewear requirements for wavelengths being used in a given laboratory. Check to see that the eyewear you have selected matches the postings and warning signs. If you have any questions contact your laser supervisor or LSO. Experienced people have picked up the wrong pair before. Don't risk an eye injury!